Hormonal doping and androgenization of athletes: a secret program of the German Democratic Republic government

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Abstract

Several classified documents saved after the collapse of the German Democratic Republic (GDR) in 1990 describe the promotion by the government of the use of drugs, notably androgenic steroids, in high-performance sports (doping). Top-secret doctoral theses, scientific reports, progress reports of grants, proceedings from symposia of experts, and reports of physicians and scientists who served as unofficial collaborators for the Ministry for State Security ("Stasi") reveal that from 1966 on, hundreds of physicians and scientists, including top-ranking professors, performed doping research and administered prescription drugs as well as unapproved experimental drugpreparations. Several thousand athletes were treated with androgens every year, including minors of each sex. Special emphasis was placed on administering androgens to women and adolescent girls because this practice proved to be particularly effective for sports performance. Damaging side effects were recorded, some of which requiredsurgical or medical intervention. In addition, several prominent scientists and sports physicians of the GDR contributed to the development of methods of drug administration that would evade detection by international doping controls.

Key Words: indexing terms: androgenic-anabolic steroids • testosterone • performance-enhancing drugs • abused drugs • sports medicine • urine

A Global Experiment in Secrecy

One of the largest pharmacological experiments in history has been running for more than three decades, namely, the administration of drugs to athletes to enhance performance in many different kinds of sports. Notably, androgenic-anabolic steroids were used with particular success for virilization of adolescent girls and female athletes. Perhaps the most remarkable aspect of this large and still ongoing global experiment is its widely accepted clandestine nature. Although the drug experiments involved many thousands of athletes, physicians, scientists, and sports and government officials, and although the success of these programs has been publicized through print, radio, and television, the nature of the program and its results largely have been kept inaccessible to direct scientific, medical, or judicially valid investigation.

Since the mid-1970s, the use of androgenic steroids and other hormonal performance-enhancing drugs has been officially banned by sports authorities, and their usage has been controlled through analysis of urine samples taken at the time of competition, i.e., after drug withdrawal, a rather inefficient and insensitive method. In addition, in many countries the use of such drugs in sports has been declared illegal and prosecuted. But these measures have had relatively little impact. Occasionally, some athletes tested positive and were banned from competition for a

period, but these occurrences were generally considered exceptions, and the athletes caught were regarded as "black sheep." The reasons for this secrecy and misinformation of the public are multifold and may include the desire to protect the clean image of international sports for political and mercantile purposes.

Athletes and coaches deny publicly and tenaciously the use of these drugs—not only because of the official ban and the recognition that such use is a violation of the principles of fairness and openness in sports, but also because athletes and sports organizations do not want to acknowledge that their achievements were not "all-natural," i.e., solely due to individual talent and effort, but instead were drug-dependent. Consequently, deception is basic to doping, and athletes, coaches, physicians, and officials have frequently and emphatically denied any use of androgenic hormones, even before these drugs were officially banned.

The role that scientists and physicians have played in this clandestine system is particularly sad, not only because these professionals actively contributed to the worldwide cheating, but also because they violated scientific and medical ethics.Remarkably, only a few of the physicians involved in doping have been held accountable for their misconduct and unethical behavior.

After a period of scientific controversy, it is now clear that androgenic-anabolichormones are effective in enhancing performance in sports (for reviews, see refs. (1)(2)(3)(4)(5)). Moreover, as has been demonstrated through scientific and official court documents, including secret doctoral theses and scientific reports, the positive effects of these and other hormonal drugs on muscle strength, aggressiveness, and performance in elite sports were common knowledge and had been in practice since the early 1960s for male athletes and since 1968 for female athletes. By far the most extensive and detailed documentation of this systematic drug abuse has come from the secret government files of one of the most successful sports nations of all times, the German Democratic Republic (GDR).

Documents of the GDR Government's Doping System

All documents of the governmentally organized and controlled hormonal doping in the GDR sports system were classified and accessible only to selected persons ("cadres"): The security was controlled by the Ministry for State Security (Ministerium für Staatssicherheit, MfS; colloquially abbreviated Stasi).[1] After the political turn ("die Wende") in late 1989, some information about a systematic doping system in the GDR, although undocumented, leaked to the Western press. At the same time, some of the officials of the GDR sport system apparently took care to assure that all compromisingdocuments were either destroyed or collected by the Sports Medical Service (Sportmedizinischer Dienst; SMD). Many documents "disappeared" from official libraries, including several doctoral theses.

Some documents were saved, however, particularly those stored at the Medical Academy of the National People's Army in Bad Saarow, east of Berlin. We, the authors of this article, succeeded in acquiring several of the secret (military classificationVertrauliche Verschlußsache) doctoral theses (for the degrees of Doctor of Medicine or Doctor of Medical Sciences) that report the results of the effects, side effects, and damages observed during controlled administrations of steroids and certain peptide hormones to students, world-class athletes, and minors (6)(7)(8). Most of this work had been performed in Saxony, at the Research Institute for Physical Culture and Sports (Forschungsinstitut für Körperkultur und Sport; FKS) in Leipzig, and at the Central Doping Control Laboratory (Zentrales Dopingkontrollabor; ZDKL) in Kreischa. In addition, one of us (W.W.F.), who in late 1990 served on a committee of the German Science Council that evaluated the research institutes of the former Academy of Sciences of the GDR, identified and copied some classified documents showing the involvement of the GDR research ministry and some of the Academy of Science institutes in the development and administration of doping drugs in sports, in particular, the Central Institute for Microbiology and Experimental Therapy

(Zentralinstitut für Mikrobiologie und Experimentelle Therapie; ZIMET) in Jena and the Institute for Research on Active Agents (Institut für Wirkstoff-Forschung) in Berlin (see, e.g., ref. (9)).

Also found were a series of scientific reports from the FKS and the research centers of the various sports associations and a handwritten protocol book, giving the times and dosages of administration of androgenic-anabolic steroids to hundreds of male and female athletes. In addition, the Deputy Director and Chief Physician of the SMD (and the GDR doping system), Manfred Höppner, himself sold some of the most incriminatingdocuments to the weekly magazine *Stern* (no. 49, 1990).

Furthermore, since 1994, highly classified reports have been found that identify MDs and PhDs of the GDR sports system who acted as "unofficial collaborators" with the MfS and security police, Stasi; in this capacity they regularly reported (under a code name) "problems," notably, those related to international sports affairs, the doping system, and possible signs of impending defection of persons from the GDR. These Stasi reports, some of which cover >30 years and >1000 pages, like other Stasi reports include examples in which a "friend" spies on a friend, a coach on his athletes, a physician on his patients, or even a husband on his wife; some also spied on their colleagues in other countries.

Altogether, >150 documents have been discovered that deal with the systematic doping in the GDR sports system. These documents provide detailed information—e.g., type of drugs, times of administration and of precompetition withdrawal, annual and daily dosages, damaging side effects to specific athletes—of the specific doping drug programs of >400 individual athletes. We have documented this evidence in several recent publications, including an expert report published by the Bund- estag, theGerman parliament (10)(11)(12). Some of these classified documents of GDR doping and doping research are referenced here (6)(7)(8)(13)(14)(15)(16)(17)(18)(19)(20)(21)(22)(23)(24)(25)(26)(27)(28)(29)(30)(31)(32)(33)(34)(35)(36)(37)(38)(39)(40)(41)(42)(43)(44)(45)(46)(47)(48).

The Early Phase, 1966–1974: An Irresistible Temptation for a Prestige-Seeking Government

In the 1960s the GDR was a relatively obscure country with a Cold War image and dominated by the "Iron Curtain" surrounding it. GDR politicians soon discerned that athletic performance would be one of the fastest and cheapest means of obtaininginternational prestige for a country with a population of only 17 million. Great efforts were made to improve athletic success, from the systematic selection of talented children for special sports schools (Kinder- und Jugendsportschulen; KJS) to thesystematic use of illegal drugs. All of these efforts were organized efficiently and with totalitarian security measures.

Success was real and obvious; from 1972 on, the small GDR was consistently in the top ranks of the medal counts, along with the US and the Soviet Union. Most of these medals were won with the help of banned drugs used for performance enhancement. Oral-Turinabol, the androgenic-anabolic steroid produced by the state-owned pharmaceutical company, VEB Jenapharm (Jena, Thuringia, GDR), was the compound most frequently used.

This steroid, a chlor-substituted version of methandrostenolone, had been introduced for clinical use in 1965 (49); by 1966, it was already being abused and administered to male athletes in the GDR sports system to enhance muscle strength, aggressiveness,and performance. At that time, androgenic steroids were already in widespread use among athletes proficient in muscle strength-dependent events in many countries, notably the US (see, e.g., refs. (1)(2)(50)(51)(52)(53)(54)(55)). In their preparations for the Olympic Games of 1968, however, GDR officials crossed another ethical barrier and administered androgenic hormones to female athletes.

The results of the administration of Oral-Turinabol to male and female athletes during the 1968–1972 Olympic cycle were systematically evaluated in various kinds of events. Oneof the most important documents, a 1973 secret report by prominent doctors and coaches (13) on the "on–off" analysis of drug effects in the shot-put and throwing events in athletics shows the drug-induced enhancement of performance for 40 world-classathletes. Fig. 1 presents a spectacular example, the drug effects on a woman shot-putter, and shows how her performance was reproducibly increased by ~2 m after daily intake of two tablets (10 mg) of Oral-Turinabol for only 11 weeks. Similarly marked effects were reported for other athletes, particularly women, and starting in 1969, this effect was further enhanced by the administration of increasingly higher doses of the drug discontinuously in cycles of a few weeks each (Fig. 1c). In their report, theseauthors (13) also introduced new terminology to code the substances used. They proposed henceforth to refer to these drugs as Unterstützende Mittel (UM; i.e., "supporting means"), stating, "Under UM we refer exclusively to anabolic steroids" ((13), p. 3, footnote 1).

View larger version (13K): [in this window] [in a new window]	**Figure 1.** Effects of an androgenic-anabolic steroid, Oral-Turinabol, on the shot-put performance (in meters, *y*-axis) of a female athlete (code identification 1/68 in *a*, 1/69 in *b*, and 1/72 in*c*) directly photographed from the secret scientific report of Bauersfeld et al. (13), as one of the numerous examples documented, chosen here because of its historic importance as the first documented case of androgenic doping of a woman (for a detailed account, see ref. (11)). *(a)* 1968. The *rectangle* from July 28 to October 13 shows the period of drug administration, and the numbers above each date show the number of tablets taken per week (here, 14, or 10 mg per day). The *curve* presents the results of the specific competitions, showing the increase of strength and performance in a fully trained woman. At the time of the first drug application in 1968, the athlete had been well trained for almost 14 years. Under the influence of the drug, however, she gained unprecedented muscle strength and improved her records dramatically within a few weeks. *(b)* 1969. The steroid was given in three cycles and at various dosages, from 7 to 21 tablets per week (i.e., 5–15 mg daily). Without the drug, she could not reach 18 m but when taking the drug, she improved her world record once more, to 20.10 m. *(c)* 1972. She took even more of the androgenic hormone, with daily dosages of up to 7 tablets per day (35 mg), in four cycles, for a total androgenic load of 1450 mg for the year. This led to her top performances in the winter indoor season *(left curve)* as well as in the summer *(right curve)* and another personal best (20.22 m). Note the much lower performance at times off the drug or after only short periods of androgenization. Also, after 4 years of systematic androgenization, her basic strength level even when not taking the drug had also increased by ~1 m, indicative of a residual effect.

The use of the drug rapidly spread to other kinds of sports, and according to Höppner, many, if not all, medal-winning GDR athletes in strength- and speed-dependent events at the Olympic Games of 1972 in Munich had been treated with Oral-Turinabol. The effects of the treatment with androgenic hormones were so spectacular, particularly in female athletes in strength-dependent events, that few competitors not using the drugs had a chance of winning.

In the GDR of the 1970s, the use of this and other androgenic hormones became customary among athletes, including minors. For a talented female athlete, it was a no-win situation: They could either take it (the drug) or leave it (give up competitive sports). The dosages were also drastically increased, at least until the late 1970s, when some of the damaging side effects became so overt that in the swimming events of the Olympic Games in Montreal 1976, where the GDR won 11 out of 13 events, journalists were inquiring about the strangely deep-sounding voices of the broad-shouldered GDR female swimmers.

In a summary report to the Stasi on March 3, 1977, SMD Deputy Director Höppner (Vol. II of his Stasi reports under the code name "Technik," pp. 243–44), described the GDR results and concluded:

At present anabolic steroids are applied in all Olympic sporting events, with the exception of sailing and gymnastics (female)[2] , ... and by all national teams. The application takes place according to approved basic plans, in which special situations of individual athletes are also considered. The positive value of anabolic steroids for the development of a top performance is undoubted. Here are a few examples... Performances could be improved with the support of these drugs within four years as follows: Shot-put (men) 2.5–4 m; Shot-put (women) 4.5–5 m; Discus throw (men) 10–12m; Discus throw (women) 11–20 m; Hammer throw 6–10 m; Javelin throw (women) 8–15 m; 400 m (women) 4–5 sec; 800 m (women) 5–10 sec; 1500 m (women) 7–10 sec...Remarkable rates of increase in performances were also noted in the swimming events of women... . From our experiences made so far it can be concluded that women have the greatest advantage from treatments with anabolic hormones with respect to theirperformance in sports... . Especially high is the performance-supporting effect following the first administration of anabolic hormones, especially with junior athletes.

Since the early 1970s many athletes of the GDR, notably females, were given not only oral androgenic steroids but also injections with androgenic hormones, including nandrolone esters or, most frequently, testosterone esters. The strong virilizing sideeffects of injectable testosterone esters were accepted by most female athletes, but some refused to participate in this additional testosterone injection program. Moreover, several other classes of doping drugs, from stimulants (e.g., amphetamines) to oligopeptides (e.g., oxytocin), were also used. A list of the doping substances described as having been used in GDR sports is given in Table 1 .%Because the effect of doping with androgenic hormones was so spectacular in female athletes, the abuse of such drugs rapidly spread not only to Eastern Block countries but also, since the mid-1970s, to countries of the Western world, including West Germany and in particular the US (1)(2)(10)(11)(50)(51)(52)(53)(54)(55)(56)(57)(58)(59)(60)(61). Thus, the women with natural ambiguity of sex characteristics, who had played a significant role in female sports until the introduction of sex test controls in the late 1960s, were soon followed by the pharmacologically induced ambiguous sex characteristics. The androgenic changes in phenotype were obvious in 1968 at the Olympic Games in Mexico City, and one of us (B.B.), a finalist in the discus throw there, later described in several articles (e.g., (50)(51)(56)(57)) the imminent threat of androgenization to women's sport and proposed out-of-competition control by analyzing athletes' urine with gas chromatography. (For international discussion, see also ref. (51).) This alarming prediction and the proposed solution were met with hostile silence and were not adopted for almost two decades.

View this table: [in this window] [in a new window]	**Table 1.** Major doping substances used in high-performance sport of the GDR.

The marked effects of androgenic hormones on performance in strength-dependentsports of men and in practically all disciplines of women's sports are also evident from the decline in top performances worldwide after the introduction in 1989 of some out-of-competition controls—despite the insufficient and imperfect nature of these tests. Fig. 2 shows the decline in "world best" performances, using as examples women's shot-put, discus, and javelin throw—typical indicator events of doping with androgenic hormones. Similarly revealing declines can be seen in most other women's events and in the men'sshot-out, discus, and hammer throw.

View larger version (11K): [in this window] [in a new window]	**Figure 2.** Decreased performances in women's strength-dependent events worldwide, after implementation in 1989 of some (though still insufficient) out-of-competition doping controls: *ordinates*present meters of performance of the world best *(upper curve)* and the average of the ten best *(lower curve)* athletes in the javelin throw*(A)*, discus throw *(B)*, and shot-put *(C)* for the years 1987–1993. This decrease since 1989 has further continued until today. In 1996, for example, no woman put the shot beyond 21 m, only two reached 20 m, and the average of the 10 best is now only 19.89 m. In 1996, many athletes were 2 m or more below their personal best from previous years. In the discus throw, no woman in 1996, including the Olympic champion, threw beyond 70 m, well short of the junior record of 74.40 m set in the GDR in 1988 by the then 18-year-old champion to be. And the best javelin throw of 1996 was shorter than the 1988 world record by >10.50 m(!).

This abrupt decline in performances after the introduction of random out-of-competition testing has been passed over in painful silence, even in scientific journals (see, e.g., the 1996 pre-Olympic issue of *Nature,* 382:12–6), but cannot easily be overlooked. For example, the best result of the 1996 Olympic gold medal winner of the shot-put in Atlanta, GDR-derived athlete Astrid Kumbernuss, would have finished only in sixth place at the 1980 Olympic Games in Moscow, almost 2 m behind the GDR winner at that time, who tossed for 22.56 m. This trend of decline, however, does not prove that today's best athletes are free from doping; it merely suggests that there is less doping than previously. In particular, the studies of GDR scientists established that "androgenic initiation" has permanent effects in girls and women: After a critical period of androgenization and an increase in muscle strength, a higher performance level is reached that does not return to pretreatment values after the drug is withdrawn (see also Fig. 1). In this respect, many of today's top athletes still profit from their previous androgenization.

1974: The GDR Organizes and Controls Systematic Doping

In 1974, GDR sport officials and the government faced an emerging dilemma. On the one hand, the effectiveness of androgenic hormones in most sporting events implied that to be internationally competitive one had to take these drugs as long as even a few of one's competitors did. On the other hand, the GDR, which, like most other countries, had officially denied the administration of such drugs and repeatedly pledged to fight against doping, was now being exposed to the problem of drug testing for androgenic-anabolic steroids at major international competitions.

In fact, analyses of urine samples for androgenic steroids were announced for the 1974 European Athletic Championships in Rome, but no positive results were published. Obviously, what the GDR Government feared most were positive test results from their successful athletes at international sporting events,[3] which would damage not only the image of the GDR as a "sports nation" but also the whole concept of the superiority of the socialist system as the better and more humane way.

Therefore, a general strategy and a centrally organized system were developed to secure both efficient hormonal doping and evasion of detection. Because of the political importance of the problem, a crucial decision was taken at the governmental level, i.e., by the Central Committee (Zentralkomitee; ZK) of the reigning Socialist Party. The final government bill, classified Top Secret, was discussed and approved on October 23, 1974, by the Commission for High-Performance Sport (Leistungssportkommission; LSK) of the ZK. Great care apparently was taken that all copies of the 9-page bill and the original protocol of the session were destroyed; ironically, however, a single copy made a few days before by the MfS survived in the Stasi files and now provides evidence that the final decisions were made at the highest governmental level and enacted by government order.

The bill of 1974 provided, among other things, that the administration of doping substances, notably androgenic steroids, to male and female athletes should:

1. be an integral part of the training process and of preparations for major international competitions;
2. be organized tightly and centrally, including regular evaluations of the results obtained and the experiences made by the sports physicians involved;
3. be directly controlled by the SMD, including the establishment of a centralized drug distribution and documentation system;
4. be further developed and optimized by research on doping in high-performance sports, with special emphasis on the development of new substances and the most efficient patterns of administration, considering both the requirements of the specific sporting event, the time of drug administration and withdrawal, and other methods to avoid detection at international meetings;
5. be taught to sports physicians and coaches in special documents and courses; and
6. take place in absolute secrecy and be classified as an Official State Secret.

It was also agreed that the research in this area should be coordinated by the FKS in Leipzig as a "Working Group Supporting Means" in a special research program financed by special government SKS grants. This comprehensive and, by GDR standards, well-funded program was originally called "Research Program 08" and later "State Plan Research Theme 14.25." Some of the reports to the government on the results of this research program have been saved (23)(31)(32)(45)(46)(47)(48); for further references, see (10)(11)(12). Medical records of most doped athletes were kept in the central office of the SMD in Berlin and at the SMD Institute in

Kreischa, which consisted of a research hospital and the ZDKL (Claus Clausnitzer, Director), a laboratory accredited by the International Olympic Committee (IOC).

The ZDKL was of increasing political importance, being primarily used not to detect drug abuse but to avoid the detection of drug abuse by GDR athletes in international doping controls. Therefore, after the positive doping case of shot-put star Ilona Slupianek in 1977,[3] every GDR athlete was required to provide a urine sample a few days before departing to an international competition at which doping controls would be performed; these precompetition samples were taken by a special delivery system to the ZDKL and analyzed. The results were transmitted, in coded fashion, first by telephone and then in written form to Höppner and the sports officials, and athletes testing positive were excluded from participation (for cases involving misuse of testosterone, however, see below). This screening system, commonly called Ausreisekontrolle ("departure control"), was apparently effective and resulted in a number of last-minute exclusions, including some prominent athletes.

The activities of seven ministries were integrated in this doping and research program, and the Central Working Group for the Protection of State Secrets of the Stasi developed a network of >1000 sport collaborators, informants, and spies ("unofficialcollaborators"). The final version of the improved Security Concept of January 10, 1979, was approved by a Stasi general and included "operative espionage" in sport and research institutions of other countries, especially in relation to developments inimproved methods for detection of doping drugs.

In this drug administration program, >2000 athletes preparing for international competitions were treated each year. In addition, numerous "cadre B and C" and junior athletes, including minors, were also treated with androgenic hormones and with substances such as human chorionic gonadotropin (hCG) and clomiphen, which stimulate endogenous testosterone synthesis (see Table 1), depending on the specificsporting event. For example, in weightlifting, the "official" steroid treatments were usually started at age 16 or 17, although cases of administration to younger children have been also documented in events in which minors could be world-class athletes: In swimming,girls of 14 or younger were given androgenic hormones; 14- to 15- year-old girls and boys were also hormone-doped in canoeing and kayaking, rowing, and various winter sporting events. All hormone-treated athletes, including minors, and the physicians and coaches involved were sworn to keep the state secret. Care was taken that adolescentsswallowed the Oral-Turinabol tablets, described as "vitamin pills," in the presence of their coaches; they were not allowed to take the tablets home or talk about such treatments with anybody, including their parents. Injections of steroids or of other drugs (Table 1) were also explained as necessary medications or prophylaxis.

In special "secrecy instructions" for physicians and scientists working in this program, the Director of the SMD identified those persons allowed to be informed about the doping details and determined the procedures for controlling the secrecy. Remarkably, the secrecy was, by and large, maintained, despite the large numbers of athletes, physicians, scientists, coaches, and officials involved.

How hormone doping was organized within the individual sport associations is documented in detail in the May 1979 Stasi report of Hans-Henning Lathan (under code name "Klaus Müller"), chief physician and international representative of the GDR Weightlifting Association (Deutscher Gewichtheberverband; DGV):

... In the DGV a first agreement is obtained by the head coach, the special coaches, and the team physician as to which athlete should receive "UM". A detailed conception for drug administration is then worked out by the team physician in a written form andsent, via the classified document office of the FKS, to Dr. Höppner and the classified document office of the SMD of the GDR... . From the central SMD office in Berlin the individual sports medical district advisory offices of the SMD in the individual counties are informed which athlete shall participate in the drug program. A

selected sports doctor is then nominated as the responsible MD for all doping drug [UM] problems in each of these county offices. This central county office doctor will inform the corresponding doctors in the sports clubs and sports associations [Sektionsärzte] about the decision concerning the drug administration to a specific athlete and will swear them to absolute secrecy. When information is given by telephone the doctors talk in coded terms; in the DGV the UM drugs are usually called "vitamins." The sports doctors [Sektionsärzte] will swear the athletes and the coaches to secrecy and this will be recorded in special "secrecy books" for classified information. The sports doctors will then hand out the weekly doses to the specific coach who in turn will give the drugs to the athlete.

This conception is controlled at all levels by random checks of the amounts of drugs distributed, consumed, and left-over. In the DGV, the athletes usually know that the drugs they receive are anabolic steroids. Here the special problem exists that so many athletes, i.e., all members of the cadres A, B and C, are part of the anabolic steroid program, so that secrecy leaks could occur.

The drug dosages of the DGV weightlifters were very high, sometimes exceeding, in the upper weight categories, 10 g per year. In 1979, for example, one GDR weightlifter took 11.550 g of Oral-Turinabol plus 13 injections of testosterone esters and hCG (for detailssee ref. (28), evaluated in refs. (10)(12)).

Altogether, the specific drug consumption of 400 GDR athletes is now well documented, including numerous world-record holders and medal winners at Olympic Games and World and European Championships (for details, see refs. (10)(11)). These athletes included most GDR gold medal winners in the swimming events since the 1976 OlympicGames (see also the next section) and all GDR gold medal winners in the throwing events of the 1988 Games.

The androgenization of girls and young women was a most effective part of the GDR doping program. The doses given were surprisingly high, and many of the top women in track and field events and in swimming took amounts of androgenic steroids that were higher than the doses taken by male athletes in the same or comparable events. As shown by a short list of examples in Table 2, many female throwers, sprinters, and jumpers took higher doses than their male teammates in the same event. For example, several female gold medal sprinters took higher amounts of male hormone than did the male GDR sprinters. The leading female athlete in one track event (sprint) was given a maximum annual dosage of 1460 mg, more than double the dosage recorded for the leading male GDR athlete in the same event.

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Table 2. Some documented dosages of androgenic-anabolic steroid (Oral-Turinabol)[1] taken by female GDR medal winners (track and field) in Olympic Games, World Championships, and European Championships.[2]

In the 1980s, special work was devoted by the GDR sports physicians and scientists to the basic problem of increased tolerance, i.e. the need to increase drug dosage over time. Therefore, they tried to determine the minimal dosage necessary for an optimal effect on performance in young athletes. The evaluations presented in Fig. 3 show two examples of the many studies conducted on teenage athletes, illustrating the effects of the initial Oral-Turinabol doping on a long

jumper and a decathlete, who also received combinations of Oral-Turinabol with mestanolone, the second most frequently used oral androgenic steroid in GDR sports (code name, STS 646; see Table 1).

View larger version (33K): [in this window] [in a new window]	**Figure 3.** Examples of the analyses of the performance-enhancing effects of the first-time administration of the androgenic-anabolic steroid Oral-Turinabol (OT), alone or together with mestanolone (STS 646), in two junior athletes: a female long jumper (W 61, *left panels*) and a decathlete (MK 12, *right panels*). The *upper panel* shows the best performances (*L*Leistung) in the seasons from 1980/81 to 1983/84 (*x*-axis) in the long jump in meters (m, *ordinate*) and in the decathlon in points (Pkt, Punkte). The *middle panel*presents in a histogram the annual dosages of androgenic steroids (mg OT: additional STS doses shown in *dotted bars*). In addition to the OT-tablets the long-jumper was in 1984 twice injected with 25 mg of testosterone propionate, and the male decathlete received additional testosterone propionate injections totaling 30 mg (3 x 10) in 1982 and 1983 and 320 mg (3x 100, 2 x 10) in 1984. The *bottom panel* presents the corresponding curves of the developments of certain test performances such as maximal muscle strength *(MK)*, speed power *(SK)*, sprint speed *(S)*, and endurance at high speed *(SA)* at different intensities *(I).* This is a direct photograph of Fig. 21 of the scientific report of Dietrich Nicklas and colleagues of the research institute FKS in Leipzig (37). The German text of the legend translates: "Relationships of the major training means used, performance development and anabolic steroid (AS) administration before and after the year of the first AS application, using the example of a female long jumper and a male decathlete." At the time of the first treatment with a total of 935 mg OT, the long-jumper was still a minor. Her example was presented by these authors to show that in young girls relatively low drug dosages can be effective for top achievements in the jumping events.

Mestanolone, which was available only as an experimental preparation from the research institute ZIMET, was also given to female gymnasts and handball and volleyball players (e.g. (44)) without having been approved for administration to humans, not even in clinical phase I trials. Höppner reported it to the Stasi as something he was not willing to be held responsible for. However, the person responsible for the illegal use of STS 646 and other steroids, a pharmacology professor, was even honored for his supportive role in the GDR doping system (32).

The treatment of young girls with androgenic hormones was especially rewarding in the medal-rich swimming events, where it secured consistent international success (e.g., (8)(32)(38)). Although most of the physicians involved were aware of and documented (see below) the damaging side effects of the drugs, and even found this treatment unethical (as they reported to the Stasi), they were subservient to the political system. Consequently, the treatment of talented swimmers in the mid-1980s with androgens started usually at age 14, with a total annual dosage of 670 mg given in three cycles with maximal daily doses of 10 mg (see refs. (38)(44) and the Stasi reports of code name "Rolf").

Considering the strictly central and tight organization of this program and its control by the Stasi, even in such a totalitarian system, a "black market" for doping drugs existed. Drugs like Oral-Turinabol and other compounds (see next section) were so much in demand that the top-cadre athletes and their coaches often wanted more than the allotted dose, and second-class athletes and coaches of minors in so-called training centers (in some cases this involved 9- to 12-year-old-boys and girls) tried everything to obtain "the stuff" unofficially on the black market. The driving force behind these efforts to obtain doping drugs through illegal sources was the importance attributed to success in sports in the GDR society, which provided increased salaries and privileges such as travel abroad for both the athlete and the coach. The Chief Physician of the DGV (28)(29)(30) repeatedly complained about the craving of the coaches for more and more steroids.

Testosterone Games: The Scientists' Contribution to Cheating

Testosterone esters played, and still play, a significant role in Olympic sports. Before 1974, such drugs were primarily used as merely another group of anabolic-androgenic steroid preparations. However, after the introduction of in-competition controls, albeit infrequent, in the mid-1970s, testosterone esters suddenly gained special importance as undetectable alternatives to be used for "steroid bridging" (also known as "bridging therapy") in the last weeks before competitions. Consequently, after ceasingadministration of the readily detectable synthetic steroids, athletes of both sexes were routinely injected with testosterone esters of various fatty acid chain lengths. This precompetition program of repeated intramuscular injections of testosterone esters had by then become a common procedure in several countries. This is also evident from the analysis by the West German, IOC-approved Doping Control Laboratory in Cologne of the unused aliquots of urine samples ("B samples") taken during the 1980 OlympicGames in Moscow: Even at the games, 7.1% of all female urine samples were still positive for testosterone doping, as revealed by a testosterone:epitestosterone (T:E) ratio >6 (62), including samples from athletes in events such as fencing, in which androgenic doping is uncommon. Only since 1982, when doping tests for testosteronewere introduced by the Medical Commission of the IOC for the 1984 Olympic Games (in fact, it had been announced by the International Athletics Association earlier) have T:E values >6 become rare findings.

In the GDR sports system, however, this "bridging" by testosterone injections was used through the late 1980s, as has been documented for hundreds of male and female GDR athletes. Fig. 4, for example, shows the pattern of testosterone bridging in 1981–1984 for athletes in several events. Moreover, several male and female athletes used testosterone ester injections throughout the season, in addition to their Oral-Turinabol and mestanolone tablets. Consequently, virilizing side effects in female GDR athletes were frequent and pronounced. Höppner reported the following to the Stasi on August 30, 1979: "Now as ever before testosterone is injected in irresponsible amounts, and this even at competitions where it does not matter so much that spectacular records are achieved."